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The gold commodity frontier: a fresh perspective on change and diversity in the global gold mining economy.

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Abstract: In recent decades, alongside the emergence of a truly globalized mining industry, we have seen a strong expansion of predominantly informal artisanal and small-scale gold mining (ASGM). While both trends are often studied in isolation, we argue that they can be seen as products of the same structural process: the widening and deepening of the gold commodity frontier. More precisely, we argue that gold mining, in an attempt to overcome several socio-ecological and socio-political limitations, has expanded outside its historical core into a range of new mining destinations (widening), and has come to rely on an intensification of production through socio-technical innovations (deepening). These processes of widening and deepening have not only led to an expansion of industrial mining, but are also, increasingly, contributing to a (geographically unequal) expansion of ASGM. In addition to targeting deposits that are unattractive for industrial mining, ASGM is better equipped to deal with socio-political uncertainty, and drives down the cost of production through a reliance on flexible informal labour. Using case study evidence from the Philippines and the DRC, we then illustrate how the processes of widening and deepening intersect with (sub-)national processes of political-economic transformation, producing different types of gold mining constellations.

Keywords: Gold; Artisanal and Small-scale Mining (ASM); Resource governance; Frontiers; Global Production Networks

1. INTRODUCTION

In recent decades, gold mining has not only expanded into increasingly remote corners of the globe, but has arguably become more diverse than ever before. In some parts of the world, gold mining is being undertaken almost exclusively by corporate entities, whose operations vary in size and scope: from junior mining firms engaged in high-risk exploration activities (Dougherty, 2013) to multinational companies that develop massive open-pit mines. In other places, we have seen the emergence of complex mining constellations, wherein mining companies share the same space with an equally diverse and predominantly informal range of artisanal and small-scale gold mining (ASGM) operations. Finally, there are those regions and countries where informal ASGM dominates the scene.

One strand in the literature has focused on the expansion of corporate mining. This expansion is seen as a logical product of neoliberal globalization and the liberalization of mining, which have allowed mining companies to enter into an alliance with governments and monopolize access to gold-bearing land (e.g. Bridge, 2004; Bury, 2005; Emel & Huber, 2008; Campbell, 2009; Camba, 2016). The expansion of predominantly informal ASGM has given rise to another strand of literature, which examines the causes, consequences, and specificity of ASM (e.g. Bryceson et al, 2014; Geenen, 2015). While there now exist different (albeit complementary) causal explanations for ASGM-expansion (see Lahiri-Dutt, 2018 for an overview), the dominant view treats it as a bottom-up response to poverty and subsistence crisis, caused in part by the uneven processes of globalization (Aizawa, 2016; Hilson & Potter, 2005; Hilson, 2009).

Hence, the image that emerges from earlier research is that of a 'dual gold mining economy' (Okoh, 2014) wherein mining companies prevail over ASGM-operators, who have no choice but to operate informally (Hilson & Potter, 2005). At several occasions, this situation has led to conflicts between mining companies and ASGM-operators (Carstens & Hilson, 2009; Werthmann, 2017). More recently, scholars have moved beyond this emphasis on opposition, by analyzing the complex and multi-layered sets of actors (including but not limited to mining companies and ASGM-operators) and relationships that develop around struggles for access –understood broadly as 'the ability to benefit' (Ribot & Peluso, 2003: 153)– to gold deposits (Geenen, 2015). Their work has provided us with valuable insights into how these relations are not only entangled with local socio-political structures (Verbrugge & Besmanos, 2016), but are also shaped by the geophysical characteristics of gold deposits (Luning & Pijpers, 2017).

While these more nuanced accounts enable an in-depth understanding of specific mining constellations, they provide little guidance for analyzing the tremendous diversity that characterizes the contemporary gold mining economy. The aim of this article, then, is to lay the foundations for an alternative analytical approach, which bridges the gap between the local and the global. More precisely, building on Jason Moore's (2000, 2010, 2012) work on commodity frontiers, we argue that in its attempts to overcome different social, political, and ecological challenges, gold mining has gone through different phases of 'widening' (though geographical expansion), and 'deepening' (through socio-technical innovation). In recent decades, this twin process of widening and deepening has not only given rise to a global gold mining industry, but has also contributed to the (geographically unequal) expansion of ASGM. Relying on two short case studies of the Philippines and the DRC, we demonstrate how these processes of widening and deepening intersect with (sub-)national processes of political-economic transformation, thus producing particular mining constellations, understood here as dynamic sets of linkages involving different modes of mineral production and associated systems of labour organization.

2. WHITHER THE GOLD COMMODITY FRONTIER?

2.1. The frontier: a contested concept

Research on resource extraction is abound with the frontier concept. It has been used as a spatial metaphor to describe wild and unruly places; as an ideological device to legitimize occupation and exploitation by states and companies; and as an analytical construct for understanding boom-bust cycles of resource-based economic growth (Barbier, 2005) and the global expansion of capitalism (Moore, 2000, De Angelis, 2004; Barney, 2009). In this article, we follow the latter approach, by showing how structural trends in the global gold mining economy are leading to its geographical expansion into specific frontier zones, which subsequently become sites of social and technological innovation. Here, the frontier is not merely a spatial, but also a scalar concept, a "*relational space of connection and articulation*" (Moore, 1998: 347) between local trajectories and global processes. In his work on Laos' resource frontier, Barney (2009: 149) usefully employs the notion of the relational frontier as a "*meso-scale heuristic device for understanding the geographies of resource extraction, displacement and marginality under global capitalism*". Inspired by such a geographical approach, different scholars have tried to make sense of the multiple articulations between 'global' and 'local' in frontier zones. From this perspective, the frontier has variably been analysed as a 'zone of incorporation', a 'zone of destruction', and a 'zone of friction'.

Historian Frederick Jackson Turner (1893) was the first to describe the American western frontier in the 19th century as a 'zone of incorporation' involving migrant settlers looking for agricultural, ranching and mineral-bearing land. Here, the frontier is depicted as an "*area of untapped potential and creative*

arena for a new democratic society" (Bryceson & Geenen, 2016: 7). Scholars working on agricultural expansion along the Amazon frontier in the 1970s and 1980s describe a similar process of incorporation, albeit in this case of pre-existing petty production into capitalist agriculture (Cleary, 1993). Yet unlike what is suggested by Turner's work, the expansion of (capitalist) frontiers and the associated incorporation of land and resources does not always go uncontested (Steffen, 1983).

Reprobating Turner's very ideological engagement with the frontier (Geiger, 2009), others have highlight its destructive potential. More precisely, frontiers often involve processes of dispossession and displacement, the depletion of environmental commons, and the privatization of public assets. Prime examples include disruptive logging in South-East Asia (Tsing, 2005; Barney, 2009), soybean and coffee plantations in the Amazon (Jepson, 2006; Brannstrom, 2000), and violent displacement for environmental conservation in Africa (Büscher, 2013). In these places, local communities lose traditional rights to natural resources, become 'adversely incorporated' as low-paid wage labour (Hickey & Du Toit, 2007), or are simply degraded to 'surplus population' (Li, 2009) that is excluded from the capitalist project altogether. This idea of the frontier as a zone of destruction is also implied in much of the literature on corporate mining, which is replete with references to 'accumulation by dispossession' (Gordon & Webber, 2008; Holden et al, 2011; Ríncon & Fernandes, 2018).

Still others have argued that frontier expansion is not simply destructive, but also creates space for something new. Here, the frontier becomes a 'zone of friction', where (new) forms of governance, social norms and cultural practices emerge from the articulation of global and local dynamics. As Tsing (2003: 5105) argues: "*The frontier is a globally travelling project, but it requires localization to come to life*". At the local level, frontier entrepreneurs 'make mining concessions' by contesting each other's claims and authority (Côte & Korf, 2018), government and security agents 'make mining territories' by levying informal taxes (Peluso, 2018) and migrant miners 'make frontier culture' in temporary settlements in the rainforest (Tsing, 2005). This work also counters the idea of global capitalism as an unstoppable, grid-making force (Tsing, 2005; Côte & Korf, 2018). Instead, it focuses on how global capitalism 'touches down' (Henderson et al, 2002) and becomes entangled in local socio-ecological and socio-political realities, thus producing variegated mining constellations. As Cleary (1993: 334) put it in his early account on the Amazon: "*it was increasingly obvious that the trend was towards greater heterogeneity in both economic structure and social relations, rather than a convergence towards capitalism.*"

This growing body of empirical research on mining frontiers has greatly improved our understanding of the expansion of mining in particular places, and the associated emergence of different types of mining constellations. At the same time, it has mostly taken the form of (sub-)national case studies that overlook the importance of structural change in the global gold mining economy, and how it contributes to changes in the anatomy of (sub-)national gold mining economies. This article tries to address this shortcoming by developing a more structuralist perspective on mining frontiers, which builds on Jason Moore's (2000, 2010, 2012) understanding of the commodity frontier as a 'zone beyond which further expansion is possible'.

2.2. The expansion of commodity frontiers: limits and solutions

For Moore, capitalism should be understood as a socio-ecological system that constantly reproduces itself through the appropriation of ecological surplus (see also Baglione & Campling, 2017). Moore's reliance on World Systems Theory and the Global Commodity Chain (GCC) perspective enables him to focus on shifting configurations in the world economy's division of labour, and examine interdependent and uneven relations between core, periphery and semi-periphery. The appropriation of ecological surplus is easier in new commodity frontiers, which are located in remote environments

where the commodification of land and labour is low, and where indigenous capacities for resistance are minimal. Yet over time, the socio-ecological conditions of production that enable the easy appropriation of ecological surplus are inevitably undermined, and new commodity frontiers deteriorate into mature ones.

Commodity frontiers have overcome these socio-ecological limitations through two (often interrelated) processes of 'deepening' and 'widening' (Moore, 2000). The 'deepening' of a commodity frontier involves the intensification of appropriation through increased inputs, and various social and technological innovations. The 'widening' of the commodity frontier refers to the geographical expansion into new frontier zones. Moore's (2010) own example of silver mining in Potosí (Peru) clearly illustrates both processes, and how they intertwine. A crisis in Central European mining laid the basis for a geographical expansion of silver mining (the widening of the silver commodity frontier) into the New World. This New World (present-day Peru) offered "*a near-perfect combination of favorable socio-ecological conditions: fabulously rich ore deposits and accessible sources of cheap labor power*" (Moore, 2010: 62). Initially, Spanish colonial mining focused on the extraction of easily accessible deposits through rudimentary mining techniques that offered income-earning opportunities to local labour. Yet as declining ore quality increased the cost of production, profitability increasingly began to depend on the deepening of the silver commodity frontier, through (1) increased investment in deeper mines and better infrastructure; (2) technological innovations (prime amongst which is mercury amalgamation); and (3) social innovations in the form of the *mita*, a system of forced labor. Yet this process of deepening could only temporarily stave off the inevitable exhaustion of the complex of socio-ecological relations that underpinned Potosí's silver mining economy. Eventually, the continued rise in production costs and the inability to mobilize cheap labour undermined Potosí's position in the global economy, and the silver commodity frontier underwent a new process of 'widening', this time into New Spain (Central America).

2.3. The nature of the gold commodity frontier

In the specific case of gold, possibilities for appropriation are determined at least in part by the materiality and the geophysical properties (Bridge, 2008). As for any other type of mineral, the depth, size and location of gold deposits is determined solely by geological forces, which restricts location choices for gold mining. At the same time, the fact that gold is geologically scarce and has a higher value to volume ratio than many other minerals implies that even a small deposit can generate windfall profits. Gold deposits are also distributed more diffusely across geographical space than many industrial metals, and appear in widely varying forms and sizes, from large and complex quartz-pebble conglomerate deposits to secondary alluvial deposits that are located close to the surface. While the former can only be targeted by capital-intensive, corporate mining, the latter can be mined with minimal use of technology and infrastructure, which makes them accessible to smaller players.

Apart from these ecological limitations, the fact that gold mining is physically located in particular places makes it susceptible to different forms of social and political risk, which may range from resistance on the part of local communities, to 'hostile' state regulation, violent conflict, and even outright expropriation (Geenen, 2018; Shapiro et al., 2018). One domain in which this is particularly apparent is that of property rights. One of the primary concerns for gold miners is the need to gain secure and –particularly in the case of large and capital-intensive mining projects– longer-term access to mineral deposits (Emel & Huber, 2011). Yet in addition to the legal complexities and contradictions inherent to many (mineral) property rights regimes, several scholars rightly remind us that resource governance is by no means the exclusive domain of the state (Fisher, 2008). Instead, even within mining concessions that are legally owned by a mining company, various actors may be vying for

control over (the benefits that accrue from) mineral wealth (e.g. Geenen & Claessens, 2013; Luning & Pijpers, 2017; Côte & Korf, 2018).

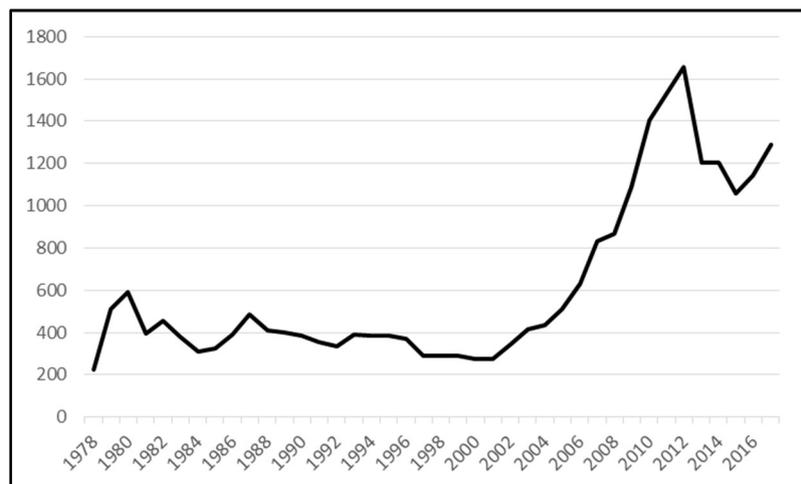
In the remainder of this article, it will be demonstrated how, in order to overcome these ecological and socio-political constraints, the gold commodity frontier has gone through different phases of geographical ‘widening’; and socio-technical ‘deepening’. In recent decades, these processes of widening and deepening have not only led to the emergence of a truly global gold mining industry, but has also contributed to a geographically unequal expansion of a diverse range of largely informal ASGM-activities.

3. THE DEEPENING AND WIDENING OF THE GOLD COMMODITY FRONTIER

3.1. Increased demand and rising prices

Between the early 19th century and the 1970s, different systems had existed (most notably the Gold Standard and the Bretton Woods system) that fixed the price of gold (Shafiee & Topal, 2010). This changed with the end of the Bretton Woods system in the 1970s. From now on, gold prices were allowed to float freely. The gold price spiked for the first time at the end of the 1970s, and a second and more sustained price increase took place in the late 2000s and early 2010s. In recent years, gold prices have fluctuated at around USD 1200-1300 per ounce.

Figure 1: Historical gold prices in USD per ounce (not adjusted for inflation) (data retrieved from www.gold.org)



While gold prices are determined by different factors, the upward trend that started after the liberalization of gold markets in the 1970s, and became particularly pronounced in the late 2000s, is first and foremost a result of increased demand. The World Gold Council has calculated that between 1987 and 2016, global gold demand has increased with 105% on an annual basis, from 2,140 tons in 1987, to 4,337 tons in 2016 (World Gold Council, 2018). Two specific trends underlie this increased demand. First, both in the early 1980s and in the late 2000s, investors massively turned towards gold as a safe haven in times of crisis. This investment was facilitated by so-called Exchange Traded Funds (ETFs), investment instruments that enable people to invest in gold without having to physically own it (Shafiee & Topal, 2010). Secondly, demand from China and India has skyrocketed due to a combination of rising income, and long-held cultural affinities for gold (Ali, 2006).

While increased demand and associated price increases have been key drivers for the global expansion of gold mining (which will be discussed in more detail below), it is important to note that the volatility of the gold price, together with currency fluctuations and geological uncertainty, makes mine

forecasting extremely challenging (Groeneveld & Topal, 2011). It is not uncommon for gold price fluctuations to lead to periodic pull-backs, or even to the outright closure of gold mining projects.

3.2. Boom and bust at the twentieth century gold commodity frontier

Turning to the production side, throughout the nineteenth century the gold commodity frontier was geographically concentrated in the gold rush areas of Australasia and North America (Reeves et al., 2010). In the twentieth century, the gold commodity frontier shifted decisively towards South Africa. After the discovery of the rich Witwatersrand gold fields, South African gold mines gradually evolved into 'gold factories' (Lynch, 2004) with a highly centralized ownership structure (Richardson et al., 2016). Despite this process of industrialization, South African gold mining continued to rely heavily on labour-intensive tunneling techniques, and therefore on the availability of a cheap mining workforce. By the 1970s, South Africa alone accounted for approximately four fifths of global gold production.

However, the 1980s and particularly the 1990s proved a turning point for the South African mining industry, which was faced with a gradual depletion of economically viable deposits, higher-than-inflation wage increases, political uncertainty at the end of the Apartheid regime, and a decline in the Rand gold price due to massive central bank sell-offs (MacMillan, 2017). In short, at a time when global demand for gold was soaring, a series of social, political, and ecological contradictions threatened to undermine the ability of the world's gold factory to meet this increased demand. In response, the global gold mining economy underwent a profound transformation, epitomized by a simultaneous deepening and widening of the gold commodity frontier.

3.3. The deepening of the gold commodity frontier through socio-technical innovation

While the mining industry has historically been a slow adopter of technological change (Clifford et al., 2018), recent decades have still seen important technological changes. Firstly, new exploration techniques and the ability to detect hidden mineralization have greatly increased the predictability of mining (Randolph, 2011). Secondly, the improvement and diffusion of cyanidation technology (for processing gold ores) has dramatically expanded the reach and profitability of gold mining (Dougherty, 2016). Prior to this 'cyanide revolution', gold mining primarily took the form of capital-intensive tunneling operations that target concentrated hard-rock deposits. Instead, the spread of cyanidation enabled the profitable extraction of diffuse, surface gold deposits. Combined with a third technological trend –the availability of larger mining equipment– cyanidation heralded a shift from underground mining to "low-grade, super-large, high-tonnage, and ultra-mechanized" open-pit mining operations (Darling, 2011: 4). However, it should be noted that this shift towards open-pit mining looks set to reverse, as new gold discoveries are at levels that are too deep for open-pit mining, and as social opposition to open-pit mining continues to increase. Finally, there are indications that the mining industry is entering a new phase of technological innovation, which is marked by an increased reliance on digital technology and 'big data' (PWC, 2017).

This trend towards automation and digitalization, which in itself contributes to a lowering of labour costs, has been combined with other strategies to drive down the cost of labour. Prime amongst these strategies is an increased reliance on different types of outsourcing and sub-contracting arrangements. More often than not, these arrangements involve subcontracting companies that operate on the fringes of the formal sector, and rely on cheap, casual, or informal labour. One country in which these outsourcing practices are particularly pervasive is post-apartheid South Africa (Kenny & Bezuidenhout, 1999).

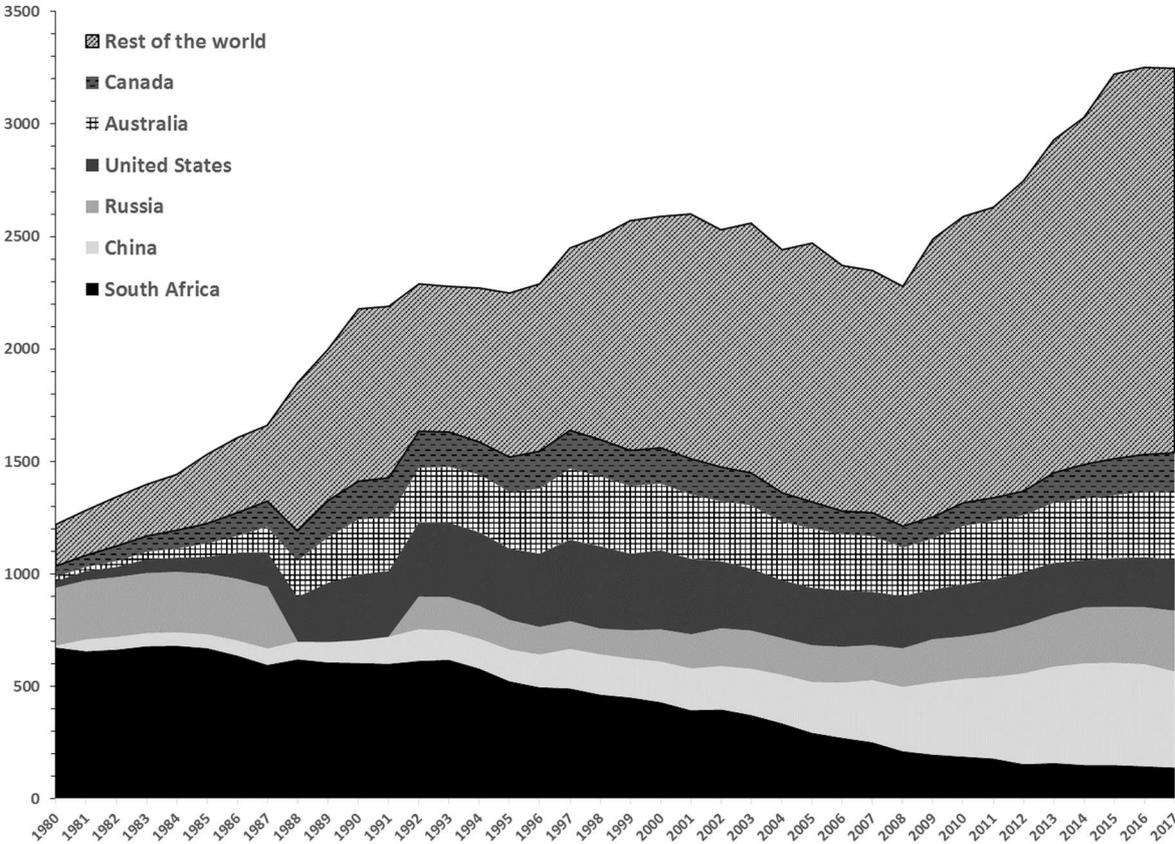
Together with rising commodity prices, these socio-technical changes in the gold mining industry could partly compensate for the trend towards declining ore reserves in historical gold mining destinations

like Australia, the United States, and Canada, which saw a revival of gold mining in recent decades (see figure 2).

3.4. The widening of the gold commodity frontier: geographical expansion

In addition to the intensification of gold mining through technological innovation, the gold commodity frontier has also expanded geographically, moving outside its historical core. This geographical expansion is clearly embodied in figure 2, which clearly demonstrates (1) the further decline of South African gold mining; (2) the revival of older gold mining destinations like the US and Australia, although annual gold mine production in these countries has remained relatively constant or has even decreased since the turn of the century; (3) The dramatic rise of China, which is now the biggest gold producer; and (4) The growing importance of the ‘rest of the world’.

Figure 2: Gold production in 6 major gold mining destinations and the ‘rest of the world’ between 1980-2017: data until 2015 were drawn from the USGS Mineral Surveys, while for the years 2015-2017, we relied on Thomson Reuters, 2018)



The geographical expansion of gold mining also becomes abundantly clear when looking at today’s top-30 gold producing countries (table 1). While China and the ‘old’ gold mining destinations (Australia, Russia, the US, South Africa and Canada) are still responsible for nearly half of global gold production, the rest is now accounted for by a geographically diverse range of new gold mining destinations, including new gold mining giants such as Peru and Indonesia, but also a large number of smaller gold-producing countries.

Table 1: Gold production per country, 2017 (source: Thomson Reuters, 2018)

China	426.1t	Kazakhstan	55.1t
Australia	295t	Mali	52.2t
Russia	270.7t	Colombia	50.6t
United States	230t	Tanzania	49.1t
Canada	175.8t	Burkina Faso	49.1t
Peru	162.3t	Philippines	47.9t
Indonesia	154.3t	Chile	35.9t
South Africa	139.9t	Dominican Republic	35.3t
Mexico	130.5t	Suriname	33.4t
Ghana	101.7t	Turkey	26.1t
Uzbekistan	84.9t	Venezuela	25.4t
Brazil	79.9t	Zimbabwe	23.3t
Papua New Guinea	61.9t	Côte d'Ivoire	22.7t
Argentina	61t	Guinea	22.4t
Dem. Rep. of the Congo	60.1t	Guyana	20.4t

South African and particularly Canadian mining companies have played an important role in the widening of the gold commodity frontier. In Canada, the government and mining companies worked out a compromise to end the sense of crisis that haunted the Canadian mining industry in the 1980s and 1990s (Heidrich, 2016). While mining companies committed to cleaning up their act at home (by respecting environmental regulation, labour rights and indigenous rights), the Canadian government rewarded them with fiscal stimuli, investments in research and development, and diplomatic support for their global expansion. South African mining capital as well started looking for opportunities outside the country, which led to the emergence of several internationally oriented gold mining firms, prime amongst which is gold mining giant AngloGold Ashanti (MacMillan, 2017). Junior mining companies also played an important role in the expansion of gold mining. Rather than being involved in the actual extraction of gold, these smaller and less capitalized firms are chiefly involved in speculative exploration activities (Dougherty, 2011, 2013; Luning, 2012). Many junior miners are strategically linked to large mining companies, who enter the scene once promising deposits have been identified and the area has been 'prepared'. Due to their lower public visibility, junior companies are better equipped to operate –and indeed thrive– in environments with high political risk. The junior mining segment is likewise dominated by Canadian companies that are supported by generous tax incentives put in place by the Canadian government (Dougherty, 2013; 2016b).

A final factor that facilitated the widening of the gold commodity frontier was the liberalization of mining (Bridge, 2004; Emel & Huber, 2008). Since the 1980s, a growing number of countries have adopted new mining codes, usually as part of a broader package of structural adjustment reforms that were championed by international lenders (Campbell, 2009). According to Bridge (2004: 407-408), *“the cumulative effect of the legal and fiscal reforms adopted by many emerging markets has been to change perceived risk/reward ratios for investing in different geologically prospective environments. As the perceived risk of investing in emerging markets like Peru, Papua New Guinea, or Mongolia has declined, so the relative risk associated with traditional investment targets (like North America or South Africa) has increased.”* In short, the liberalization of mining regimes has unlocked a wealth of hitherto untapped potential for mining companies.

3.5. Limits to industrial gold mining

Summarizing the above, when a crisis threatened to undermine the gold commodity frontier in South Africa and Canada, it underwent a parallel process of deepening (through socio-technical innovation) and widening (through geographical expansion). While few would argue that the expansion of

industrial gold mining has reached its endgame, it is indisputable that the industry is facing a number of interrelated challenges that hinder its further expansion in particular places.

A first set of challenges is broadly related to ecological scarcity and growing cost pressures (Mooiman et al., 2016; Humphreys, 2018). Major historical gold mining destinations like Australia, Canada, South Africa, and the United States, have seen a clear trend towards declining gold ore grades. While price rises and technological innovations could partly compensate for this decline (see 3.3), many observers agree that the end of the 'golden age' is near (Kerr, 2012; Mooiman et al., 2016). World-class gold deposits are becoming increasingly difficult (and increasingly expensive) to find, and those that remain often have a very complex mineralogy (World Gold Council, 2018). The extraction of these complex deposits requires ever-greater amounts of energy, chemicals, and (skilled) labour, which in turn increases not just the cost of gold production, but also its impact on the environment.

A second set of challenges is related to the socio-political context in which mining companies are forced (due to the 'fixity' of gold deposits) to operate. Each year, the Fraser Institute publishes its 'Survey of Mining Companies', which provides a good indication of how the mining industry perceives risk in different mining destinations (for the latest report see Fraser Institute, 2017). While low-risk destinations generally include high-income countries and -regions with stable and liberal regulatory regimes; high-risk destinations include countries with more restrictive and unstable regulatory regimes and/or a high degree of political instability. Examples of the latter situation include China, South Africa, but also several of the new mining destinations listed in table 1, such as Venezuela, the DRC, Zimbabwe, and the Philippines. In these countries, several sources of socio-political risk may co-exist.

A first socio-political risk factor is societal opposition to mining. The intensification of gold mining and its expansion into 'greenfield territories' have led to growing resistance on the part of civil society organizations and/or local (indigenous) communities, to what is often referred to as 'neoliberal mining' (e.g. Rasch, 2012; Himley, 2013). This resistance can be driven by various factors, including concerns about the ecological impacts of mining, a (perceived) lack of benefits for local communities, and a general sense of exclusion (Conde, 2017). In other cases, opposition takes the form of labour unrest. This is particularly apparent in the South African mining industry, which relies on the availability of a cheap and productive workforce. Mining companies have responded to growing societal opposition by paying more attention to company-community relations, but also through various forms of counter-mobilization (Geenen & Verweijen, 2017). This need to pay increased attention to company-community relations has become a factor in its own right contributing to rising production costs (Mooiman et al., 2016). Governments, meanwhile, have responded through varying combinations of regulation and/or repression (Conde, 2016).

This brings us to a second socio-political risk factor: regulatory uncertainty. In various countries, societal concerns over the impact of mining on development have led to recurrent episodes of resource nationalism, whereby governments take regulatory action (e.g. taxes, local content requirements, renegotiation of mining contracts, nationalization) in a bid to increase national control over mineral resources (Humphreys, 2018). While resource nationalism is typically associated with Latin American countries such as Bolivia (Kohl & Farting, 2012), a similar trend has periodically surfaced in sub-Saharan countries like Tanzania, South Africa (Bothma, 2018) and Zimbabwe; or in Asian countries such as the Philippines (Chaloping-March, 2014) and Indonesia (Junita, 2015). In these countries, attempts to attract foreign investment through liberal mining regimes have alternated with periods marked by a more circumspect if not hostile treatment of foreign mining capital.

A third and final factor is political instability. In different regions across the globe, the expansion of the gold mining industry is hindered by political instability and armed conflict. In countries like the

Philippines (Verbrugge, 2015a) and the DRC (Verweijen, 2017), resistance to industrial mining activity intersects in complex ways with the broader dynamics of armed conflict. Another case in point is Colombia, where government attempts to attract increased mining investment risk being undermined by continued political instability in mineral-rich regions (NOREF, 2015).

3.6. Whither the expansion of ASGM?

3.6.1. The growing importance of ASGM for global gold production

So far, our analysis has deliberately focused on industrial gold mining, while neglecting the expansion of ASGM. This expansion has been ongoing for decades, but became particularly apparent in the wake of the gold price increase of the late 2000s and early 2010s. Due to pervasive informality, estimates about ASGM are notoriously unreliable. In a recent report (IGF, 2017), the Canadian Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development estimated that more than 40 million people in over 80 countries are now directly involved in ASM, with at least half of them engaged in gold mining. Together, they are responsible for an estimated 15-20 percent of global gold production. The overwhelming majority (70-80 percent) of these operations takes place without government recognition (Verbrugge & Besmanos, 2016).

Seccatore et al. (2014) have undertaken a rare attempt to estimate production levels for ASGM in different countries. In table 2, we contrast their estimates with total mine production data for each of the countries included in table 1 that were also included in the estimates. To be sure, this is no foolproof method: the data are outdated, and aside from possible problems with the estimates made by Seccatore et al., figures for total mine production per country (which were drawn from the USGS 2012 mineral yearbook) are prone to a significant degree of distortion. For example, while figures for some countries include official (Brazil) and/or unofficial (Peru) ASGM-production, others explicitly exclude it (Ghana, Indonesia). For still other countries (China, Venezuela, DRC), mine production is based entirely on estimates, and no further information is available as to whether these estimates include ASGM-production. Despite these caveats, table 2 can provide us with a rough indication of the relative importance of ASGM in each country. In absolute terms (column 2), ASGM-production is biggest in Latin-American countries (Peru, Brazil, Colombia), followed by the Philippines, Indonesia and South Africa. In relative terms (ratio ASGM-production / mine production), in 5 of the 18 countries (Peru, Indonesia, Brazil, Guinea, Zimbabwe) ASGM-production equaled 20-50 percent of mine production. In four countries (Colombia, Philippines, Guyana, Venezuela) this figure reached 50-100 percent. In one country (DRC), estimated ASGM-production actually outweighed estimated total mine production (see below).

Table 2: Mine production versus estimated ASGM-production per country, 2011 data

	Gold mine production in tonnes (2011) (source: USGS, 2012)	Estimated ASGM-production in tonnes (2011) (source: Seccatore et al., 2014)	Ratio ASGM-production / official gold production
Peru	166.2t	40t	24
South Africa	180.18t	17t	9.4
Mexico	84.1t	0.9t	1
Indonesia	96.1t	20t	20.8
Brazilⁱ	65.2t	21t	32.2
Ghana	82.9t	4,1t	4.9
PNG	61.8t	2-5t	3.2 -8

Tanzania	44t	2-3.5t	4.5-8
Colombia	55.9t	41,4-50.8t	74.1-90.9
Mali	35.7t	1,7t	4.8
Burkina Faso	31.8t	0,5-1t	1,5-3.1
Philippines	31.1t	28t	90
DRC	3.5t	5t	142,9
Zimbabwe	12.8t	2.8t	21.9
Guyana	11.3t	7.6t	67.3
Guinea	15.7t	6t	38.2
Venezuela	12t	7t	58.3

3.6.2. Existing causal explanations for ASGM-expansion

The dominant causal explanation for ASGM-expansion views it as a bottom-up response to poverty. This ‘poverty-driven’ view emerged from empirical research in sub-Saharan Africa, where an increase in agricultural poverty is pushing people into off-farm activities such as ASGM (Hilson & Garforth, 2012). This increase in agricultural poverty may be confounded by other, more context-specific factors. In Zimbabwe, ASGM-expansion has been linked to an increase in poverty following the government’s failed economic policies (Mabhena, 2012). In countries such as Ghana and Tanzania, the liberalization of mining has paradoxically contributed to the growth of informal ASGM, as many of those retrenched from state-led mining companies subsequently found their way into ASGM (Hilson & Potter, 2005). Meanwhile in places like Sierra Leone (Maconachie, 2011), Mali (Teschner, 2014), and the Eastern DRC (Kelly, 2014; Geenen, 2015), political crisis, conflict, and the general breakdown of political and economic structures, have contributed to a further expansion of ASGM.

While we fully recognize that poverty is an important –and arguably even the most important– factor underlying the unrelenting supply of new ASM-recruits, poverty alone does not explain why many countries have seen a gradual evolution towards more advanced ASGM-activities with a higher degree of mechanization and capitalization. To understand this evolution, we also need to take into account the role of investors. One example is Guyana, whose gold mining economy is dominated by advanced ASGM-operations that are financed by a heterogeneous group of financiers, including self-made miners, urban elites, and emigrants that invest remittances (Clifford, 2011). In sub-Saharan African countries such as Cameroon (Weng et al., 2015) and Ghana (Hilson et al., 2014), the increased involvement of Chinese investors has laid the basis for a far-reaching transformation of ASGM.

Another set of explanations focuses on the geological characteristics of gold deposits (Lahiri-Dutt, 2018: 11). As noted earlier, some gold deposits are simply too small, shallow, scattered, or remote for industrial gold mining. At the same time, these types of deposits may be very well suited for ASGM-activities with lower levels of mechanization. In regions such as Madre de Dios in Peru (Damonte, 2016) and Choco in Colombia (Tubb, 2015), a thriving ASGM-economy has developed around diffuse alluvial gold deposits that are mined using various surface mining techniques. The fact that mining companies and ASGM-operators often target different types of deposits also helps explain why in some cases, they are able to co-exist peacefully (Geenen, 2015; Luning & Pijpers, 2017).

Together, these different explanations—which variably emphasize poverty, opportunity, and geology—go a long way in explaining ASGM-expansion in particular places. But as we argue in the next section, they cannot fully account for the ever-expanding reach of ASGM, as well as the volumes it produces (see table 2). Furthermore, research in different countries has documented how the interaction between ASGM and corporate mining is producing different types of gold mining constellations. In

some cases, this relationship is tense, and may even involve violence (Carstens & Hilson, 2009). In other cases, relationships are more consensual, with mining companies tolerating ASGM inside their concession (Luning, 2008; Luning & Pijpers, 2017). In Ghana, it has recently been documented that mining companies are buying tailings from ASGM at below-market prices (Bansah et al., forthcoming). In the Northern Philippines, ASGM-operators and Benguet Mining Corp. have even entered into a highly unequal contract mining scheme (Verbrugge & Besmanos, 2016).

3.6.3. ASGM-expansion as a product of a deepening and widening gold commodity frontier

In short, existing research has made great strides in analyzing the expansion of ASGM and its interaction with industrial mining. Yet it has mostly remained confined to the (sub) national level, and therefore fails to make sense of the changing role and position of ASGM in the global gold mining economy. Instead, the image that emerges from the literature is one of a dual gold mining economy (Okoh, 2014) that is dominated by multinational gold mining companies, to the detriment of a subsistence-oriented ASGM-sector whose expansion is seen as a bottom-up response to poverty. It is important to emphasize here that we are not questioning the fact that poverty is indeed a driving factor underlying the relentless expansion of ASGM. Rather, we argue that poverty-driven explanations need to be complemented with an analysis of structural change in the global gold mining economy. More precisely, we argue that the global –but geographically unequal– expansion of ASGM and industrial gold mining are products of the same overarching process: a widening and deepening gold commodity frontier that seeks to overcome challenges related to ecological scarcity, social opposition, and political instability.

Firstly, and building on the ‘geological’ explanations discussed in the previous section, ASGM-expansion offers a (temporary) response to the problem of geological scarcity, because it targets isolated surface deposits that cannot be mined profitably using capital-intensive, industrial mining techniques. At the same time, increased investment in ASGM, and the availability of modern mining equipment (e.g. backhoes and explosives) and processing methods, have greatly expanded the ‘reach’ of ASGM, which is now able to target bigger and more complex deposits. Particularly important in this regard is the gradual introduction of cyanidation in ASGM in countries like the Philippines (Verbrugge, 2014), Ghana (Ferring et al., 2016), and Indonesia (Langston et al., 2018). After heralding a new expansionary phase in industrial gold mining in the 1980s, there is now increased evidence that a similar ‘cyanide revolution’ is taking place in ASGM. As suggested by one of the reviewers of this article, this cyanide revolution may well be accelerated by the impact of the Minamata convention on the price of mercury.

Secondly, ASGM-expansion provides a response to rising costs of production ASGM operators can avoid costs associated with fiscal or environmental regulation by virtue of them being informal. More importantly, ASGM does not adhere to labour regulation, and instead relies on the use of flexible informal labour (Verbrugge, 2015b, Geenen 2015)). It typically operates through revenue-sharing arrangements that involve workers and financiers, but sometimes also landowners, customary and/or statutory authorities, and various other rent seekers (e.g. Cleary, 1990; Fisher, 2007; Geenen, 2015). To be sure, revenue-sharing creates opportunities for social mobilization and for the emancipation for ordinary workers, which helps to explain the appeal of ASGM (Bryceson & Geenen, 2016). At the same time, it allows the financier to shed off a large part of the risk to the workforce (Godoy, 1988). Moreover, there is increasing evidence that the ongoing evolution towards more capital-intensive

ASGM-activities tends to go hand in hand with the emergence of unequal revenue-sharing arrangements with a high degree of labour exploitation (Verbrugge, 2015b¹).

This defiance of regulation is related to a third point about ASGM, which can more easily overcome several of the socio-political challenges identified in section 3.5. Firstly, its informal character makes ASGM less sensitive to regulatory volatility. This does not mean that government regulation has no impact on ASGM, as is illustrated by the DRC's mining ban in 2010-2011 (Geenen, 2012) or the expulsion of Chinese miners in Ghana (Tschakert, 2016). It does mean, however, that government regulation is implemented in untidy ways with unintended consequences (Arnaldi di Balme & Lanzano, 2013; Côte & Korf, 2018). Formalization efforts often reach an ASGM elite only (De Haan & Geenen, 2016) and typically do not include the workforce (Verbrugge & Besmanos, 2016). Moreover, a growing number of ASGM operators now straddle the border between formality and informality (e.g. Ferring et al, 2016). Moreover, while there may well exist tensions and even conflicts involving ASGM-operators and surrounding communities (e.g. Grätz, 2004), societal opposition to ASGM tends to be less widespread. Instead, ASGM often enjoys support from local residents, for whom it is first and foremost an engine for employment. ASGM also provides rent-seeking opportunities to local powerbrokers (Le Billon, 2001). While in some cases –and in line with an influential argument in the literature on conflict minerals– this may lead to conflict over access to ASGM-rents, in other cases we have seen the emergence of ‘shadow networks’ composed of various state and non-state actors that coalesce around informal ASGM (Duffy, 2007; Verbrugge & Adam, 2016). And while ASGM-operations typically lack formal mineral tenure rights, they are often more in tune with actually existing land tenure arrangements (Nyame & Blocher, 2010; Verbrugge, Cuvelier & Van Bockstael, 2015). In short, while often vilified by governments that decry destructive and ‘illegal’ mining, ASGM is often more deeply entangled with local socio-political structures and land tenure systems.

In short, ASGM-expansion can be seen as a product of both a widening (i.e. the expansion into new gold mining destinations with a challenging political context) and a deepening (i.e. socio-technical innovations) gold commodity frontier. Of particular importance for this latter process (deepening through socio-technical innovation) is the observation that an evolution towards technologically more advanced ASGM has gone hand in hand with the increased –and arguably the increased– exploitation of informal mining labour.

4. THE GOLD COMMODITY FRONTIER TOUCHING GROUND

In the preceding section, it was argued that the expansion of industrial gold mining and ASGM, which are often seen as two separate processes that lead to a dual gold mining economy, can alternatively be seen as products of the same overarching process: the deepening and widening of the gold commodity frontier. In this final section we illustrate this claim by zooming in on the situation in the Philippines and the DRC, two new gold mining destinations where ASGM accounts for the majority of gold produced (cf. table 2). This exercise will reveal how the expansion of gold mining intersects with (sub-)national processes of political and economic transformation, thus producing different types of gold mining constellations. It will also serve to illustrate how, rather than a linear evolution towards a wider and deeper gold commodity frontier, the processes of widening and deepening can intersect, contradict, and may at times be reversed.

4.1. The Philippines

¹ A similar argument was made by Cristiano Lanzano during a conference on ‘Mining in Comparative Perspective’ hosted by Ghent University on 13-14 December 2017.

The Philippines have a long history of 'traditional' gold mining (Caballero, 1996). While traditional gold mining emerged largely intact from the Spanish colonial period (1521-1989), under American colonial rule (1898-1946) the gold commodity frontier underwent a phase of deepening and widening. What started out as small-scale prospecting activities undertaken jointly by American soldiers and the native population gradually evolved into a capitalized, corporate mining industry (Habana, 2001). Yet rather than leading to the disappearance of ASGM, ASGM-activities would persist alongside corporate mining. While some of the newly established mining companies started buying ASGM-gold, there was also a gradual transfer of technology to ASGM-operations (Ibid.). The gold mining boom ended with the economic crisis of the 1930s and the outbreak of World War 2. Under the impetus of increased global demand for (metallic) minerals, the mining industry recovered in the post-war, post-independence period (Ofreneo, 2009). Throughout the country, mining companies were starting new mining projects (including many copper-gold mining projects) that typically relied on a skilled and expensive workforce. The mining industry reached its heyday during the Marcos dictatorship (1965-1986), which saw mining as a key source of foreign revenues, and as an ally in its quest to develop remote frontier regions, prime amongst which is the southern island of Mindanao (Lopez, 1992).

By the mid-1980s, different factors triggered a deep crisis in the mining industry. At the global level, the recession of the 1980s and a glut in global mineral supply led to a drop in mineral prices (Lopez, 1992; Ofreneo, 2009). Domestically, increased instability due to armed insurgency and a worsening economic situation were threatening the Marcos regime, which became increasingly preoccupied with self-enrichment. Rising production costs led to the closure of a growing number of mining operations. The crisis in the mining industry was aggravated by a series of environmental disasters in the 1980s and 1990s, which led to the emergence of a vocal anti-mining movement (Holden, 2005). Meanwhile despite repeated claims about a shift towards a "*mining-based development paradigm*" (Holden, 2005), governments in the post-Marcos era have been blowing hot and cold over the future of mining. Inconsistent political action and widespread social mobilization have led to the emergence of a highly unstable regulatory regime, which continues to scare away potential investors (Verbrugge, 2015a). Moreover, in places such as eastern Mindanao, investor risk is increased further by the presence of the communist New People's Army, which targets mining operations as part of its campaign of 'revolutionary taxation' (Verbrugge & Adam, 2016). Together, these different factors prevent a full-blown expansion of corporate mining, and have instead created fertile conditions for the expansion of informal ASGM.

In regions such as Benguet and Davao, the scaling-down or even the outright closure of mining operations in the 1980s and 1990s led to the availability of a (semi-)skilled mining workforce. Together with a growing group of poor and unemployed, they increasingly became involved in ASGM, both inside and outside the company concessions. Over time, these ASGM-activities not only expanded into increasingly remote areas, but also benefited from the involvement of investors, which included self-made miners, Chinese-Filipino merchants, and local elites. This investment enabled the introduction of more modern mining (e.g. hydraulic pumps, generators, and electric drills) and processing technologies (Verbrugge, 2014). Of particular importance was the gradual introduction of carbon-in-pulp processing (cyanidation) by chemists and engineers that were previously employed in the mining companies. Cyanidation made ASGM much more cost-effective, and enabled it to target increasingly remote and complex deposits. Significantly, this technical transformation of ASGM went hand in hand with the emergence of more unequal revenue-sharing arrangements that favor financiers and various other rent-seekers (e.g. local politicians, local landowners, armed actors), to the detriment of a workforce that works in exceedingly risky conditions and receives a declining share of the revenues (Verbrugge, 2015b). Over time, ASGM has also become deeply entangled within the local socio-political fabric, with places such as Compostela Valley province in Mindanao witnessing the rise of a class of

miner-politicians that managed to consolidate their control over ASGM through a variety of regulatory and coercive strategies (Verbrugge, 2015c). All the while, national government efforts to increase control over ASGM were having very little effect. Instead, even in rare cases where a permit has been issued, it remains limited to a minimalistic recognition of mineral tenure rights, while neglecting questions of environmental regulation, let alone questions of informality in the workforce (Verbrugge & Besmanos, 2016).

The gold commodity frontier entered a new expansionary phase in the late 2000s and early 2010s. On the one hand, rising gold prices and the increased involvement of foreign (Korean and Chinese) investors led to a renewed expansion of ASGM, which increasingly takes the form of 'medium-scale mining', as respondents in the Philippines referred to when talking about more advanced ASGM. On the other hand, the governments of Gloria Macapagal-Arroyo (2001-2010) and Benigno Aquino (2010-2016) were undertaking (half-hearted) attempts to revive a fledgling mining industry, by handing out a growing number of mining permits, mostly to junior Filipino mining companies that entered into joint ventures with foreign (mostly Australian, Canadian and/or Chinese) investors. Yet the extent to which these companies engage in actual mining operations varies, and in some cases they simply hold on to their claim for speculative purposes (Verbrugge & Besmanos, 2016).

Together, these seemingly oppositional trends have led to the emergence of a heterogeneous range of mining constellations, which are entangled within local socio-political structures. In Diwalwal, the most notorious gold mine of the Philippines, ASGM-operators have not only clashed with each other, but also with a mining company that has attempted to take over the area (Verbrugge & Adam, 2016). In a mining concession in the nearby municipality of New Bataan, different mining companies had no choice but to tolerate ASGM inside their concession. During a field visit in 2014, an employee from one of these companies was complaining about 'data leakage': a practice whereby company personnel is selling geological information to ASGM-operators². Meanwhile in Acupan, in Benguet Province, Benguet Mining Corporation and ASGM-operators are engaged in a contract mining scheme, whereby ASGM-contractors are responsible for extracting gold deposits, which are subsequently processed and sold by the company (WD; Verbrugge & Besmanos, 2016).

4.2. The DRC

Traces of precolonial gold mining were found in DRC's North Kivu province, where gold was used to make jewellery and royal attributes for the chiefs (Vwakyanakazi, 1992: 377). In South Kivu, Maniema and Ituri, alluvial deposits were identified in the early 20th century. Panning (in rivers) and skimming (from the topsoil) techniques were used until the early 1920s (Bakonzi, 1982: 115). Around that same period Belgian capitalists – some of whom had been granted immense territories by King Leopold II – invested to extract gold on a larger scale. Capital investments and new technologies enabled these companies to start mining underground and generate high profits. Buelens and Marysse (2009) attribute these impressive profit rates, apart from the international hunger for minerals and the ample availability of Belgian capital, to the extremely low labour costs: Congolese mineworkers earned a meagre 2 to 4 percent of European wages. Exploitation and coercion were rife, and workers were not even allowed to move around freely. Towards the end of the 1930s this exploitative system of labour control made way for a more paternalistic model, out of a concern about the 'stabilization' of the workforce. After the economic crisis of the 1930s, Congo's economy recovered and boomed during and after the Second World War, until the decolonization movement in 1958 provoked a massive flight of capital (ibid.).

² Interview with representative of Batoto Mining company, New Bataan, 18/1/2014.

Around this time, company agents in South Kivu started to document 'gold thefts' inside the concessions. In 1963 these reportedly amounted to 30-40 percent of MGL's (*Minière des Grands Lacs*) production. However, the miners were protected by police and magistrates (Geenen, 2014: 104). Traders smuggled the gold to neighbouring Uganda, where prices were almost five times higher. Throughout the 1960s and 1970s, ASGM flourished alongside industrial gold mining. In South Kivu's most important mining town Kamituga, by 1979 an estimated 60 percent of the population was involved in ASGM (Kasele & Kasongo, 1979). Throughout the 1970s, industrial production went in decline, due to a lack of investments in exploration and production, a consequent degradation of mining equipment, and a loss of trained engineers (Bedidjo, 2007). President Mobutu's nationalization policies (1973-1975), while serving the president's neo-patrimonial politics, effectively transferred control over mining infrastructure to incapable managers. When copper prices fell in 1975, the Zairian state was plunged into a deep economic crisis.

The president's decision to liberalize the exploitation and trade in gold and diamonds (1982) facilitated the widening of the gold frontier. Despite the moribund state of the Zairian transportation network, ASGM moved into increasingly remote territories, and became connected to Ugandan and Burundian smuggling networks. Rising gold prices enabled these networks to generate huge profits, allowing them to enter into alliances with high-ranking politicians and military personnel (Geenen, 2014: 236). In 1983, industrial gold production dropped by 39 percent, and ASGM-production grew to four times the volume of industrial production (Tshibanza & Tshimanga, 1985: 339). In the same year, SOMINKI (*Société Minière et Industrielle du Kivu*), a gold and tin producer in South Kivu, made an attempt to officially buy gold from ASGM, but as the price they offered was much lower than that in the black market, they did not succeed (Geenen, 2014: 112). They did, however, allow technically unemployed ex-workers –whom they had been forced to lay off– to dig in abandoned parts of the concession.

In the 1990s, a combination of hyperinflation, political crisis and an armed rebellion against the Mobutu regime led to the complete collapse of what was left of the mining industry. During two successive wars (1996-97 and 1998-2003), ASGM became an integral part of a regional war economy, which was dominated by unscrupulous gold traders, Ugandan and Rwandan troops and various domestic rebel groups relying on forced labour, violence and illegal taxation. For a growing number of displaced people, ASGM became the only viable income source (Vlassenroot, 2004). For mining companies, it was nearly impossible to operate in such an environment. South African-based AngloGold Ashanti and Canadian junior Banro Corporation, which had signed contracts with both the old and the new regime, were forced to suspend their activities. After 2003 they were supported by the new Kabila regime, which prioritized investment in large-scale mining. While new investments boosted industrial production in the early 2010s (peaking at 31.8 tonnes in 2015, ITIE, 2017), both Kibali Goldmines (a joint venture of Randgold, AngloGold Ashanti and *Société des Mines d'Or de Kilo-Moto*) and Banro Corporation faced a number of technological, infrastructural, financial and socio-political challenges (including resistance by local communities and ASGM operators) that slowed down their growth in 2016 and 2017 (Geenen & Verweijen, 2016). Different types of gold mining constellations have emerged in the past decade: from ASGM-operators working independently in demarcated parts of Banro's concession in Kaduma, over a subcontracting system set up around Mongbwalu (Matthysen et al, 2011), to forced displacement and violent mobilization of ASGM-operators around Namoya (Geenen & Verweijen, 2016). Around 2010, a combination of increased regulatory pressures on coltan and tin (related to international concerns about conflict minerals), depleting reserves in some of the big coltan and tin mines, and rising gold prices, provoked a massive shift of workers into ASGM. In some of the bigger sites such as Misisi, Kamituga and Sabunda, investment in technological innovation (ball mills and dredges) is driving up production, yet at the same time continuing insecurity – as a result of armed group presence such as in Misisi and Shabunda, or

corporate presence such as in Kamituga – is hampering this. ASGM, which is entirely informal, is now estimated to employ almost 200,000 miners in the Eastern DRC alone, with an annual production of an estimated 11.6 tonnes per year (IPIS, 2016).

5. CONCLUSION AND DIRECTIONS FOR A COMPARATIVE RESEARCH AGENDA

This article has shed new light on two seemingly oppositional trends in the global gold mining economy: the emergence of a global gold mining industry, and the expansion of a heterogeneous range of informal ASGM-activities. We have argued that both trends should be seen as part of the same overarching process: the deepening and widening of the gold commodity frontier, which seeks to overcome a series of socio-ecological and socio-political challenges. This argument was illustrated on the basis of the situation in the DRC and the Philippines: when industrial gold mining encountered its limits, the gold commodity frontier continued to widen and deepen, albeit mostly in the form of informal ASGM-activities. These ASGM-activities are not better insulated from the ebbs and flows of national regulation, but they are also more intimately entangled with local socio-political structures and land tenure systems, and can drive down production costs through their reliance on flexible informal labor.

We end this article with a suggestion for a future research agenda. In recent years, a growing body of research has markedly advanced our understanding of gold mining in different countries and regions. With this article, we hope to contribute to the development of a research agenda that moves beyond a focus on (sub) national dynamics, by connecting them to global trends. This, in turn, will enable more systematic comparison between (sub) national gold mining economies. The idea of ‘mining constellations’ has been used here as an empirical concept that can help to uncover the imbricate nature of different production modes and overcome a dualist view on the gold mining economy. But at the same time, more work remains to be done to strengthen the theoretical and analytical foundations of such a comparative research agenda. We strongly believe that a commodity frontier perspective can be a useful starting point for such a comparative research agenda³, because a) it brings in a *longue durée* perspective that helps to uncover boom and bust cycles and related changes in the dominant modes of mineral production, b) it exposes connections between places and allows to question the position of a particular mining constellation in the global mining economy, and c) it allows to uncover the causal processes that lead to the emergence of different types of gold mining constellations in different localities.

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³ The literature on global commodity chains (GCC), global value chains (GVC) and global production networks (GPN), which has inspired us for our research project ‘InForMining: an in-depth study of informalization processes in global gold production’ (2018-2020, funded by Research Foundation Flanders), provides further conceptual tools to make sense of changes in the global gold mining economy. Recent work on ASM has adopted this perspective (Hilson et al 2016, Geenen 2018, McQuilken and Hilson 2018) and may serve as a starting point for connecting (sub-)national to global trends.

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